DESIGN GUIDELINE 4.3.3
FULL CONSTRUCTION-PHASE COMMISSIONING PROCEDURE

Scope

This procedure defines the scope of work for the Commissioning Authority (CxA) when a project is identified as requiring full construction-phase commissioning (Cx).

Related Sections

U-M Design Guideline Sections:
DG 4.3 – Building Commissioning
DG 4.3.4 - Reduced Scope Construction-Phase Commissioning Procedure
DG 4.3.5 – Commissioning Plan Procedure
DG 4.3.6 – General Commissioning Procedures

U-M Master Specification Sections:
MS 017823 – Operation and Maintenance Manuals
MS 019100 – Project Commissioning

Reference Documents

ASHRAE Guideline 0, “The Commissioning Process”
ASHRAE Guideline 0.2, “Commissioning Process for Existing Systems and Assemblies”
ASHRAE Guideline 1.1, “HVAC&R Technical Requirements for the Commissioning Process”
ASHRAE Guideline 1.5, “Commissioning Process for Smoke Control Systems”
ASHRAE Standard 202, “Commissioning Process for Buildings and Systems”
Building Commissioning Association, "The Building Commissioning Handbook"
USGBC, “LEED® v4 Reference Guide for Green Building Design and Construction”

General

All project systems and equipment shall be commissioned, including but not limited to the systems and equipment listed in the project’s commissioning specification and MS 019100 – Full Project Commissioning.

Perform the following construction-phase Cx activities. Reference the Related Sections above for additional requirements.

1. Develop a project-specific Cx plan by utilizing the U-M "Generic Sample Commissioning Plan (Manual)". All activities and forms described in this sample plan shall be implemented for the Cx process.

2. Conduct an on-site Cx kick-off meeting.

- Require each contractor's lead field person and Cx lead person to attend.
- Clarify the requirements and benefits of the Cx process.
- Explain the Cx plan process.
- Explain the O&M manual requirements.
- Write and distribute Cx meeting minutes.

3. Issue the project-specific Cx plan to the Construction Manager (CM) or General Contractor (GC) for them to complete and maintain.

4. Develop the Cx forms for contractor completion and insertion into the Cx plan.
   - The Cx forms include but are not limited to pre-installation, pre-start (or check/test/start) and functional test check sheets.
   - All major equipment shall have pre-installation and pre-start check sheets.
   - Review equipment installation/startup manuals for equipment being commissioned and incorporate manufacturers' requirements into the pre-start and functional test check sheets.
   - Distribute the forms in advance of the Cx activities.
   - Require each contractor to complete and insert into the Cx plan the portion of each form that relates to their work.

5. Develop project specific Cx status check sheets. See the example in the U-M Generic Sample Commissioning Plan (Manual).

6. Conduct periodic on-site Cx meetings (typically one every month at the beginning, increasing to one every week for the last third of the project).
   - Require CM or GC and contractor participation in the Cx meetings. Invite the U-M Project Manager to the Cx Meetings.
   - The purpose of Cx meetings is to track progress toward successfully commissioning each system and to resolve issues that could prevent successful commissioning. Utilize the Cx status check sheets to track progress.
   - Periodically review the draft O&M manual and verify O&M information is being added.
   - Write and distribute Cx meeting minutes.

7. Assess the impact of commissioning each system or piece of equipment on the project schedule.
   - Develop a logical "order and timing" for each Cx event.
   - Facilitate the CM's or GC's integration of Cx events into the project's CPM schedule.
   - When a system or equipment is being started early to facilitate construction, remind the CM or GC that the early-started systems and equipment shall be commissioned once before startup and a second time before final acceptance.

8. Participate in the contractor submittal review process and send comments to the A/E.
   - Require the CM or GC to forward contractor submittals simultaneously to both you (the CxA) and the A/E for a parallel review.
     - Review the submittals which are critical to the Cx process.

    - Focus on identifying issues that will prevent successful commissioning. Typical examples include performance data that does not meet project requirements, alarm contacts not provided for DDC, unclear sequences of operation, inadequate service and electrical clearances.
    - Focus on compliance with plans and specifications and on issues that are often overlooked. Typical examples include un-approved manufacturers (including motors provided with equipment), sub-components (such as motors and valves) not in compliance with related specification sections, etc.
  - Require the A/E to incorporate Cx comments with their comments or contact you to discuss. Copy the U-M Project Manager when submitting comments to the A/E. Notify the U-M Project Manager if your comments were not incorporated.
  - Obtain a set of the A/E reviewed and stamped submittals or arrange for the storage of a set at the project site.

9. Identify equipment or systems (including pre-purchased equipment) requiring factory testing, manufacturer startup or other special documentation.
   - Verify requirements are met and documentation is inserted into the Cx plan.
   - When the CxA will witness factory tests, the project will pay for travel-related expenses.
   - Review equipment test reports or similar reports significant to the commissioning effort.
   - Participate in the resolution of issues brought to light as a result of such testing or reports.
   - Document the final resolutions in the Cx manual.

10. Document any quality control deficiencies found during the Cx process.
    - Maintain an Open Issues Log or equivalent and frequently provide a copy to the CM/GC.
    - Request the CM or GC incorporate Cx open issues into the project's open issues list.

11. Generate Requests For Information (RFIs) to the Architect/Engineer regarding questions about design intent or functionality issues of systems to be commissioned, and follow up on closure of all such issues.

12. Participate in the Coordination Drawing Process.
    - Attend a minimum of two contractor coordination drawing meetings. Monitor the process to verify reasonable coordination is occurring between trades. Report on contractor progress.
    - Assist contractors in identifying required equipment maintenance access and require maintenance access spaces be delineated on the coordination drawings.

13. Monitor the proper protection from dirt, debris, and water, ducts, piping, air handlers, VFDs and similar equipment.

14. Validate proper flushing, cleaning and water treatment of plumbing and hydronic piping systems.
    - Review the specification requirements for flushing and cleaning, disinfecting and chemical treatment. Validate contractor compliance throughout construction.

- Review and approve flushing and cleaning plans.
- Conduct a chemical pre-treatment conference with the contractors to verify treatment procedures, discuss coordination with existing piping networks, and to coordinate treatment activities with the construction schedule. Document the meeting in the Commissioning Report.
    - Ann Arbor central campus projects including Housing: Because the University's water treatment service company will become responsible for water treatment at project completion, invite them to the conference by contacting the U-M water treatment coordinator (Nicholas Vanderkolk (nevander@umich.edu)). If they or others bring up concerns during the meeting, address through normal commissioning protocols. (For U-M Hospital and Athletics projects and other U-M campuses, determine the equivalent University representative(s) to invite in consultation with the U-M Project Manager.)
- Witness flushing and cleaning of these systems.
- Assure chemical testing verifies proper rinse of the cleaned systems.
- Require that the initial water treatment of each hydronic system occurs immediately after flushing and cleaning is completed.
- Obtain reports verifying water treatment was maintained throughout construction and insert them in the Cx plan.
- Conduct a final chemical treatment turn-over meeting and insert the final validation report in the Cx plan. Document the meeting in the Commissioning Report.
    - Invite the same University representatives as invited to the pre-treatment conference; address any concerns that arise through normal commissioning protocols.

15. Participate in contractor duct leak testing.
    - Review and approve duct leak testing plans.
    - Verify a sampling of ductwork for cleanliness.
    - Witness duct leak tests. Listen and feel for air leaks.
    - Witness follow-up leak tests.

16. Participate in and document the initial energization of major power distribution system equipment.
    - Review the final short circuit and protective device coordination studies provided by the A/E. Identify secondary fuse sizes, breaker settings and automatic transfer switch settings that are missing from the study.
    - The electrical testing agency will document in test reports the fuse sizes, breaker settings and ATS settings installed in most of the equipment. Compare them with the A/E's report and identify discrepancies. Verify with contractor help the fuse sizes and equipment settings not included in test reports to achieve 100 percent verification.
    - Verify electrical equipment and cables have passed the specified electrical testing.
    - Verify electrical equipment is labeled and contains arc flash hazard warning labels.
    - Witness the initial energizations of major electrical equipment.

17. Participate in and document the startup of major equipment.
    - When required by specification, assure a manufacturer's representative starts up the equipment.
    - Test all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal, and emergency conditions under all operating conditions.
    - Verify sound, vibration and other specified tests are performed after startup.
    - Collect the check-test-start sheets for inclusion in the Cx plan.

18. Participate in the functional testing and commissioning of each system.
    - Participate in 100 percent of the functional testing of major equipment.
    - Functionally test 100 percent of terminal units that are controlled in any way by occupancy sensors.
    - Functionally test 100 percent of terminal units or zones that provide temperature, humidity, pressure, or similar control outside of what would be the design criteria for a typical office, e.g. those serving museum, special storage, or similar spaces.
    - Functionally test 100 percent of terminal units serving any space designated as a lab.
    - Otherwise, randomly sample 20% minimum of fan coil units, VAV boxes, chilled beams, plumbing fixtures, lighting occupancy sensors, and similar high unit count equipment. If significant issues are found, random sample in additional increments of 10% until no significant issues are found.
    - Verify each system and its components are installed per specification and manufacturer's requirements and with adequate maintenance accessibility.
    - Verify the testing of all system functions. Include all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal, and emergency conditions under all operating conditions.
    - Verify all system controls, safeties and alarms.
    - Verify systems and components provide the OPR and BOD requirements.
    - Document all issues revealed as a result of Cx.
    - Verify all documented issues are resolved.
    - Advise the U-M Project Manager and A/E of design problems.
    - Document separately issues that cannot be corrected within the project scope.

19. Validate the test and balance (TAB) procedures and review the TAB report.
    - Conduct air and water balance "pre balance" conferences.
    - Verify air and water balance procedures proposed by the TAB contractor are appropriate for the project.
    - Monitor air and water balance activities.
    - Review air and water balance reports.
    - Document incorrectly balanced systems, incomplete balancing, insufficient balancing data, and system deficiencies identified as a result of the balance work.
    - Verify any incomplete TAB work is completed and any system deficiencies identified as a result of the TAB activities are rectified.

20. Commissioning of the following systems shall be limited to tracking that the required AHJs inspect and document their approval of the system. Correspond with the U-M Project Manager to assure these activities occur. Insert approval documentation into the Cx Plan.
    - Fire alarm systems: State of Michigan BFS, U-M Fire Marshal, U-M Code Inspection.
        - The CxA shall verify and separately document, in advance of the AHJ's inspection, that any mechanical equipment controlled by the fire alarm system (directly or indirectly) operates per the intended sequence of operation. Examples: Smoke or fire/smoke dampers in AHUs and in ducts and smoke control zones, fans, actuated doors or door release mechanisms, stairway or smoke zone pressurization systems, atrium smoke control systems, etc..
    - Elevators: State of Michigan Elevator Inspector, U-M Plant Elevator Shop.
    - Emergency responder radio and cell phone signal enhancement systems: U-M ITSComm Engineer, U-M Code Inspection.

21. Additional requirements for certain systems: Verify the contractor demonstrates all modes of system operation including User programming of system functions to the appropriate User representative(s). Determine who the appropriate User representatives are in conjunction with the U-M Project Manager:
    - Security Systems: Commission similar to any system, however assure the U-M Division of Public Safety and Security along with the appropriate user representative is involved
    - Access Control Systems: Commission similar to any system, however assure the appropriate user representative is involved.
    - Audio/visual, electronic messaging, room scheduler and similar electronic systems: Commission similar to any system but arrange for the User representative(s) to participate in the functional testing.
    - Cage and rack washers, sterilizers, and similar specialized User equipment provided by the project: Arrange for and attend a contractor demonstration of all modes of system operation and User programming functions presented to the appropriate User representatives. Once the User agrees the equipment functions per specification, document that fact in a report sent to the User and the U-M Project Manager. Insert such reports in the Cx Plan.

22. On projects providing a new or replacing or expanding an existing emergency power distribution system, perform a "pull the plug" test of the system.
    - Arrange for a test in which normal primary power to the building is shut off.
        - U-M Inspection will verify engine-generator and/or battery systems start all emergency loads in their required times, and these loads operate as intended.
        - The CxA shall verify engine-generator and/or battery systems start all legally required standby loads (e.g. smoke pressurization fans) and optional standby loads in their required times, and these loads operate as intended.
        - Verify no normal loads receive engine-generator or battery power.
        - Verify all "loss of normal power", "transfer to generator power" and similar alarms function as intended.
    - Arrange for restoration of normal primary power to the building.

- Verify emergency and standby loads return to normal power and operate as intended.
- Verify all normal loads resume operation as intended.
- Verify engine-generator and/or battery systems return to standby mode.
- Verify all alarms return to normal.

23. Generate and issue periodic Cx Reports.
    - Identify systems that do not meet the OPR or BOD.
    - Document the Cx activities performed, problems identified, and Cx activities still outstanding. Include any quality control deficiencies found during the Cx process.
        - Identify the responsible party assigned to correct the problem or deficiency.
        - Distribute the report to the contractors, the U-M Project Manager, and the A/E.
    - Immediately before Substantial Completion, provide the U-M Project Manager with an overall report documenting all Cx activities performed, problems identified and Cx still outstanding. Clearly identify any OPR or BOD requirements not met.
    - If Cx activities will occur after Substantial Completion, issue an updated Cx report when all Cx activities are complete.

24. Review and approve the O&M manuals.
    - Require that O&M manuals be submitted to the CxA using the project's submittal tracking process.
    - Review for compliance to Specification 017823.
    - Verify manual is logically organized, indexed and labeled.
    - Verify manual is complete and project specific.
    - When manual is approved, instruct CM or GC to produce three more copies.
    - Transmit all four copies to the U-M AEC Project Manager who will forward to the AEC Facility Information Center (FIC).
    - Insert the transmittal in the Cx plan.

25. Manage and conduct Owner training sessions.
    - Verify the contractor organizes the vendor training required by the specifications.
    - Determine attendance requirements via communication with the Owner's Plant Operations Training Coordinator.
    - Propose training schedules for Owner approval.
    - Notify Owner's personnel of each training session and track their attendance through completion.
    - Develop an outline style training document generally describing each major system, areas served etc. that will assist maintenance personnel in becoming familiar with each system.
        - Provide such training in conjunction with equipment-specific training, where appropriate.
    - If a vendor training session does not meet the specification requirements, require the vendor to provide the training session again.
    - Document each training session (trainer, attendance, date, time, location, and brief report).

26. If the project is pursuing LEED, provide any commissioning activities required by the “LEED v4 Reference Guide for Green Building Design and Construction” to support the LEED effort.

27. If the project is pursuing LEED v4 Energy and Atmosphere Credit "Enhanced Commissioning", contact the project’s LEED Coordinator for guidance. Produce a systems manual and perform the other construction-phase Cx activities required for the paths and options the project has selected for this credit.

28. If the project is pursuing LEED v4 Indoor Environmental Quality Credit “Construction Indoor Air Quality Management Plan”, assist the U-M Project Manager with this effort.
    - Assist with developing an indoor air quality (IAQ) management plan that assures ductwork and air handling equipment are protected from dust and debris throughout construction and temporary use.

29. Perform Cx closeout.
    - Review and approve the final Cx plan submittal.
    - Generate and issue a Final Cx Report.
    - Verify that all project Cx requirements have been met.